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COMPLIANCE IS MANDATORY

John C. Stennis Space Center
Isocyanate Hazard Control Plan

Approval/Concurrence

Signature on file
Michael A. Pannell, PhD, CIH 10/16/2020
NASA Occupational Health Officer Date

Document History Log

Status/Change/ Revision	Change Date	Originator/Phone	Description
Basic	June 5, 2013	M. Stewart, 8-1302	Initial Release
Revision A	October 1, 2014	M. Stewart, 8-1302	Revision clarified responsibilities of NASA and Contract Project Managers and Supervisors. Added ventilation option of push-pull systems. Added requirement for NASA and Contract Project Managers and Supervisors to complete a Pre-Job Checklist. Actual checklist added to Appendix A.
Revision B	October 6, 2015	B. Walters, 8-1234	In Section 4.2, functional role names of NASA Project Managers, Resident Contractor Construction Managers, and Resident Contractor Supervisors were clarified.
Revision C	April 12, 2016	K. Wright, 8-3263	Replaced FOSC with SOC throughout the document
Revision D	October 15, 2020	M. Pannell 8-2555	Update references, revise local exhaust ventilation requirements, include isocyanate use approval process.

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1. PURPOSE

It is the policy of Stennis Space Center (SSC) to keep isocyanate exposures as low as reasonably achievable. The acquisition or use of any isocyanate material at SSC is restricted without first obtaining approvals using SSC Form 862, *SSC Hazardous Material Approval Form*. The requirements of this work instruction form the basis of a systematic process to anticipate, identify, evaluate, and control the hazards associated with the use of isocyanate material at SSC and apply effective exposure control measures to protect personnel from its adverse effects.

Background
Isocyanates are known sensitizers, meaning that past exposure to an isocyanate material may cause a later, much smaller exposure to trigger a severe reaction. Isocyanates also have poor warning properties, meaning that a person can be overexposed without sensing the presence of isocyanates through smell, irritation, etc.

The two most common commercial isocyanates are toluene diisocyanate (TDI); and diphenylmethane diisocyanate (MDI). Other forms of isocyanates also available and include hexamethylene diisocyanate (HDI), naphthalene diisocyanate (NDI) and isophorone diisocyanate (IPDI). TDI evaporates most easily and is therefore the most harmful of these isocyanates.

Isocyanates are common components of polyurethane foams, thermoplastic elastomers, adhesives, and many polyurethane coatings. Isocyanate use or application may be a single or a two-part mixture of isocyanate with an accelerator to set a resin material. This Stennis Common Work Instruction (SCWI) provides restrictions on the use at SSC of products which contain greater than 1.0% of any combination of reactive isocyanate materials.

All reactive isocyanates can pose a health risk through inhalation of vapors and aerosols, absorption through the skin or eyes, and through inadvertent ingestion.

2. APPLICABILITY

This SCWI is applicable to all NASA/SSC personnel, NASA/SSC Prime Contractors and NASA Direct Construction Contractors and grant recipients only to the extent specified or referenced in their respective contracts, grants, and agreements. This SCWI provides restrictions on the use at SSC of products which contain greater than 1.0% of any combination of reactive isocyanate materials.

3. AUTHORITY/REFERENCES

2.1. SCWI 1800-0005 Hazard Communication
SSC-862, *Hazardous Materials Approval Form*
SSC Form 890, *Isocyanate Project Approval Form*
SSC Form 891, *Required Isocyanate Exposure Control Measures*

SSC Form 892, *Isocyanate Quantitative Exposure Assessment*
29 CFR 1910.1000, Air Contaminants
29 CFR 1910.1200, Hazard Communication
American Conference of Governmental Industrial Hygienists (ACGIH), *Threshold Limit Values (TLVs)*
National Institute for Occupational Safety and Health (NIOSH), *Recommended Exposure Limits (RELs)*
A Summary of Health Hazard Evaluations: Issues Related to Occupational Exposure to Isocyanates, 1989 to 2002, Department of Health and Human Services, Centers for Disease Control and Prevention National Institute for Occupational Safety and Health, January 2004
Respirator Selection for Diisocyanates, 2009, 3M Corporation, Scott Shinn, CIH , 3M OH&ESD Technical Service and Regulatory Affairs.
SSC Heat Stress Program Work Instruction (SCWI-8715-0014)

4. RESPONSIBILITY

4.1. NASA Industrial Hygiene Manager

The SSC NASA Industrial Hygiene Manager (NIHM) has the overall responsibility for this SCWI.
Review and disposition/approve submitted SSC Form 862 - *Hazardous Materials Approval Form*

4.2. NASA Project Managers, Resident Contractor Construction Managers, and Resident Contractor Supervisors

NASA Project Managers, NASA Prime Contractor Construction Managers, and Resident Contractor Supervisors are responsible for oversight of projects which involve the use of isocyanate materials, and shall:

4.2.1. Obtain approval to bring isocyanates onto the facility through the use of the *Hazardous Materials Approval Form*, SSC Form 862.
4.2.2. Ensure compliance with this SCWI.
4.2.3. Prior to each approved isocyanate project startup, visually verify that all required Contractor qualifications and requirements (training, respirator qualifications, etc.), exposure control measures (ventilation equipment, respiratory and protective equipment, and other required materials or equipment) are present and properly functional.
4.2.4. Prior to project startup, obtain a completed and approved *Isocyanate Project Approval* Form (SSC Form 890).
4.2.5. Inform, or otherwise provide hazard information to all personnel potentially exposed to isocyanates.

4.3. Isocyanate Program Manager (IPM)
The SOC Certified Industrial Hygienist is the Isocyanate Program Manager.

The Isocyanate Program Manager shall:

4.3.1. Review Form SSC-862 and associated documents for clarity and completeness prior to submitting to the NIHM for review/approval.
4.3.2. Perform periodic checks to verify personnel comply with requirements of Form SSC-862 and this work instruction.
4.3.3. Perform qualitative and quantitative isocyanate exposure assessments as necessary to determine initial and continued exposure potentials to various processes, use of products, and various tasks associated with isocyanate product use for NASA and NASA Prime Contractor operations.
4.3.4. Prescribe effective isocyanate exposure control measures.
4.3.5. Verify the effectiveness of isocyanate engineering control measures.
4.3.6. Perform periodic reviews of technical information relative to the health effects of isocyanate materials, detection methods, and exposure control measures.
4.3.7. Verify the continued effectiveness of this SSC work instruction.

4.4. Stennis Operating Contract (SOC) Industrial Hygiene Professionals will:

4.4.1. Work under the direction of the Isocyanate Program Manager, and assist in carrying out the responsibilities of the IPM identified in this work instruction.

5. EXPOSURE ASSESSMENTS

5.1. Qualitative exposure assessments will be performed by the IPM or SOC Industrial Hygiene Professional for each project using isocyanate materials. The assessment will include:
5.1.1. Evaluation of the isocyanate material proposed for use
5.1.2. Review of method or process of isocyanate material use
5.1.3. Determination of project Similar Exposure Groups (SEGs)
5.1.4. Review of project description, associated tasks and processes
5.1.5. Review of previous exposure assessment results of similar projects and tasks
5.1.6. Review of engineering controls (ventilation systems) proposed for use

5.2. Quantitative hazard assessments will be performed by the IPM or SOC Industrial Hygienist (IH) for NASA and NASA Prime Contractor projects using isocyanate materials. Quantitative assessments will be documented using SSC Form 892, *Isocyanate Quantitative Exposure Assessment*. Airborne isocyanate concentrations will be measured to the nearest part per billion of isocyanates.

5.3. Similar Exposure Groups (SEGs) will be identified, based on the different worker tasks required for the project. Common isocyanate project SEGs may include: foam appliers, coating sprayers, product mixers, project support personnel, product appliers, product trowelers, etc.

5.4. If available, qualitative and quantitative hazard assessment information and data from previous similar isocyanate projects will be reviewed for each proposed project.

5.5. Based on current and previous exposure assessment information and data, effective exposure control measures will be prescribed in writing by the IPM or SOC IH and documented of SSC Form 890, *Isocyanate Project Approval*.

5.6. At a minimum, five representative measurements are required for each Similar Exposure Group (SEG) for each project in order to: determine exposure potentials; measure the effectiveness of ventilation control measures; and prescribe the proper respiratory protection.

6. EXPOSURE CONTROL MEASURES

Potential worker inhalation exposures to isocyanates shall be primarily controlled through the use of engineering controls, specifically ventilation. The use of respiratory protection may be required as a secondary inhalation exposure control measure as determined by the IPM or SOC IH. In general, ventilation controls are expected to control exposures to less than 5 parts per billion (ppb) STEL. This value is 25% of current OELs. The supplementary respiratory protection is intended to further reduce those residual exposure levels as low as reasonably achievable; below 1 ppb STEL. This concentration is also the lowest level of quantification for most direct-reading field instruments used for exposure assessments. The required respiratory protection will be determined by the IPM or SOC IH on a project-by-project and task-by-task basis. Where dermal exposure hazards have been identified, barrier personal protective equipment (e.g., Tyvek® coveralls, nitrile gloves, etc.) will be used.

The required project and task-specific exposure control measures will be documented on SSC Form 891, *Required Isocyanate Exposure Control Measures*.

6.1. Engineering Controls

Effective ventilation will be required as the primary exposure control measure for all isocyanate projects, except as provided below, beginning in section 6.1.5.

6.1.1. Dilution ventilation will be used for most isocyanate project applications. Dilution ventilation must provide an air velocity of at least 100 feet per minute (fpm) at the point of isocyanate generation. The ventilation system air volume (capacity) must be sufficient to maintain the above velocity specifications. The system must be positioned to move the captured air and contaminants away from the workers' breathing zones and into an immediate area not occupied by other personnel. The spot ventilation discharge must be repositioned as the isocyanate point of generation moves in order to maintain the required velocity and positioning criteria.

Obstructions that interfere with system air flow or redirect the contaminated air stream back toward the worker or adjacent workers are not permitted.

6.1.2. Local exhaust ventilation may be used in cases where the specific point of isocyanate generation is stationary and occupies a relatively limited area. The system must provide an air velocity of at least 100 fpm at the point of isocyanate generation and then discharge the contaminated air to a location free of personnel. As the point of isocyanate generation location changes, the local exhaust inlet must be repositioned continually to maintain the required capture velocity. In general, to be effective, the center of the local exhaust ventilation inlet duct or hood must remain and be repositioned such that it is in direct alignment and within 18 unobstructed inches of the point of isocyanate generation.

6.1.3. Push-Pull Ventilation Systems are a combination of positive pressure and local exhaust ventilation used together to move the contaminated air from work areas and into a location free of personnel. The system must move air away from workers and have an air velocity of at least 100 fpm at the employee work area(s). The system must be positioned to move the captured air and contaminants away from the workers' breathing zones and into an immediate area not occupied by other personnel.

6.1.4. It is recommended, but not required, that the NASA Project Managers, Resident Contractor Construction Managers, and Resident Contractor Supervisors first qualitatively verify ventilation system performance and configuration in advance of project startup, before the IPM or SOC IH later verifies system performance prior to project startup. The IPM or SOC IH will provide a tool for the project manager/supervisor to test system performance.

6.1.5. The above ventilation system velocity criteria and system configuration must be measured and verified by the IPM or SOC Industrial Hygiene Professional prior to beginning the portion of a project involving the opening of any isocyanate material containers, mixing, applying, or using any isocyanate materials. The ventilation system evaluation will be documented on SSC Form 890, *Isocyanate Project Approval*.

6.1.6. Variance requests must be made in advance to the IPM by the NASA Project Managers, Resident Contractor Construction Managers, and Resident Contractor Supervisors during the review phase of a project.

6.1.7. A request for a ventilation variance will only be approved by the IPM if the use of a ventilation system has been credibly proven by the requestor to be technically infeasible. Each variance request to the IPM must be in writing (e.g., email), describing the technical infeasibility of the use of ventilation systems for the proposed isocyanate project, activity, or task(s). The IPM will review the written variance request and will document a decision (approval or denial) on SSC Form 893, *Request for Ventilation Variance*.

6.1.8. Should a ventilation variance request be approved by the IPM, supplied air respiratory protection shall be used as the required inhalation exposure control

measure, not subject to modification.

6.2. **Respiratory Protection**

Respiratory protection will only be used as a secondary exposure control measure to augment engineering controls, except as specified in Section 6.1.7.

6.2.1. Respirators must be selected and used in accordance with regulatory requirements described in the Occupational Safety and Health Administration's (OSHA) Respirator Standard, 29 CFR 1910.134.

6.2.2. The IPM or SOC IH will determine if, when, and the type of respiratory protective devices required for each approved project and task. This respirator evaluation will be determined by:

6.2.2.1. Type of isocyanate material being used

6.2.2.2. Methods of isocyanate material use and associated worker tasks

6.2.2.3. Performance effectiveness and configuration of engineering controls

6.2.2.4. Measured airborne isocyanate STEL concentrations

6.2.2.5. Professional judgments of IPM or SOC IH.

6.2.3. The IPM or SOC IH are authorized to modify the required respiratory protection during the course of a project for individual tasks and/or SEGs in accordance with the respirator selection criteria outlined in Section 6.2.4. The authorization must be in writing and after completion SSC Form 891, *Required Isocyanate Exposure Control Measures*. At any time during a project, the IPM or SOC Industrial Hygiene Professionals may prescribe more protective levels of respiratory protection than specified by the criteria below, based on their professional judgments. Additionally, respiratory protection upgrades may be authorized by any person associated with the project. These upgrades may be due to variable isocyanate concentration levels, inconsistent ventilation performance or configuration, inconsistent project supervision, or other variables.

6.2.4. The following selection criteria will be used for respirators for each isocyanate project and for each task/SEG (in addition to ventilation);

6.2.4.1. Supplied Air Respirator - fullface or air helmet/hood

- Quantitative hazard assessment not completed, or
- Isocyanate concentrations ≧5ppb STEL, or
- With approved variance of ventilation requirement (no ventilation)

6.2.4.2. Fullface Air Purifying Respirator (APR) or Powered Air Purifying Respirator (PAPR) (Organic Vapor/OV cartridge with P100 filter)

- Isocyanate concentrations <5 ppb STEL

6.2.4.3. Half Mask Air Purifying Respirator (OV cartridge with P100 filter)

- Isocyanate concentrations <5 ppb STEL

6.2.4.4. No Respiratory Protection

- Calculated STEL isocyanate concentration <0.25 ppb

6.3. **Personal Protective Equipment**

Personal protective equipment (PPE) will be used to control dermal exposures.

6.3.1. Barrier clothing (body, gloves, etc.) according to dermal contact exposure potential, based on a task-by-task dermal hazard assessment.

6.3.2. Selected barrier clothing must provide adequate penetration and permeation resistance to the isocyanate material being used.

6.4. Heat Stress Control

6.4.1. If heat stress is a potential exposure hazard, it must be controlled as a separate and distinct hazard. Reducing required PPE or respiratory protection for isocyanate exposure control shall not be used as a rationale for heat stress control.. With the above requirement noted, isocyanate project personnel may request that dermal exposure hazards and PPE requirements be re-evaluated by the IPM or SOC IH to determine if alternate (and cooler) PPE is possible, without sacrificing worker protection.

6.4.2. Refer to SSC Heat Stress Program work instruction (SCWI-8715-0014) for additional details.

6.5. IPM and SOC Industrial Hygiene Professionals

6.5.1. For NASA and NASA Prime Contractor projects, the IPM and SOC IH Professionals shall prepare a Safety Plan of Action (SPA), SOC Form 285, for all field assessments and other tasks. While all task and area-specific hazards will be reviewed, particular emphasis shall be devoted to identifying and controlling hazards associated with isocyanate exposures and walking and working hazards.

6.5.2. IPM and SOC IH shall have a full-face respirator air-purifying respirator (APR) available for use when open isocyanate materials are present should monitored isocyanate results warrant their use. These respirators should only be used within the above respirator selection criteria.

6.5.3. Where possible, the use of extended sample tubing will be used on isocyanate sampling instruments to reduce exposure potential via distance and to reduce the need to climb onto elevated work surfaces.

7. ISOCYANATE PROJECT STARTUP APPROVAL

Before beginning the isocyanate project startup approval process by the IPM or SOC IH, the NASA Project Managers, Resident Contractor Construction Managers, and Resident Contractor Supervisors for the isocyanate project is responsible for verifying the required Contractor qualification documentation is provided in advance, and the required equipment is on-site and functional prior to startup. This verification will assure there are no outstanding items that would cause delays in project start-up on the scheduled date and time. This verification process shall be documented on a NASA Project Managers, Prime Contractor Construction Managers, and Resident Contractor Supervisors Pre-Job Checklist located in Appendix A of this work instruction.

Prior to startup of the portion of any project which involves the opening of any isocyanate material containers, mixing, applying, or using any isocyanate materials, the project must receive an on-site evaluation and approval by the Isocyanate Program Manager or a SOC IH. The evaluation and approval shall be documented on SSC Form 890, *Isocyanate Project Approval* Form.

The main purpose of the startup evaluation is to assure that the requirements of this work instruction are ready for immediate startup implementation.

The startup evaluation will include, the verification of the following:

7.1. Effective communication of project/task-specific requirements
7.2. Project scheduling
7.3. Ventilation Equipment
  7.3.1. Is on-site
  7.3.2. Is required type and condition
  7.3.3. Is in sufficient quantities for each potentially exposed worker
  7.3.4. Meets performance and configuration requirement of this work instruction
7.4. Required PPE and respiratory protection:
  7.4.1. Is on-site
  7.4.2. Correct type
  7.4.3. If breathing air is required, it meets Grade D specification or better quality
  7.4.4. Workers are qualified to use them (medical, training, fit tests, etc.)

8. RECORDS

The following records shall be maintained by the Isocyanate Program Manager:

NASA Project Manager, NASA Prime Contractor Construction Manager, and Resident Contractor Supervisor Pre-Job Checklist
SSC Form 862 SSC Hazardous Material Approval Form
SSC Form 890, Isocyanate Project Approval
SSC Form 891, Required Isocyanate Exposure Control Measures
SSC Form 892, Isocyanate Quantitative Exposure Assessment

SSC Form 893, Isocyanate Project Request for Ventilation Variance Decision

9.0 ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
APR	Air Purifying Respirator
HDI	Hexamethylene Diisocyanate
IH	Industrial Hygienist
IPDI	Isophorone Diisocyanate
IPM	Isocyanate Program Manager
MDI	Diphenylmethane Diisocyanate
NDI	Naphthalene Diisocyanate
NIHM	NASA Industrial Hygiene Manager
NIOSH	National Institute for Occupational Safety and Health
OELs	Occupational Exposure Limits
OSHA	Occupational Safety and Health Administration
OV	Organic Vapor
PAPR	Powered-Air Purifying Respirator
ppb	parts per billion
PPE	Personal Protective Equipment
RELs	Recommended Exposure Limits
SCWI	Stennis Common Work Instruction
SEGs	Similar Exposure Groups
SOC	Stennis Operating Contract
SPA	Safety Plan of Action
SSC	Stennis Space Center
STELs	Short-Term Exposure Limits
TDI	Toluene Diisocyanate
TLVs	Threshold Limit Values

APPENDIX A:
NASA Project Manager, NASA Prime Contractor
Construction Manager, and NASA Prime Contractor Supervisor
PRE-JOB CHECKLIST

Project Manager/Supervisor Name: _____
Isocyanate Project Name: _____
Projected Project Startup Date: _____

REQUIRED ITEMS NEEDED PRIOR TO PROJECT STARTUP APPROVAL:
Prior to beginning the isocyanate project startup approval process by SOC IH, the NASA Project Manager, Resident Contractor Construction Manager, and Resident Contractor Supervisor for the isocyanate project is responsible for verifying the required documentation is provided in advance, and the required equipment is on-site prior to startup. This verification will assure there are no deficient items that would cause delays in project start-up on the scheduled date and time.

This completed checklist must be provided to the IPM or SOC IH prior to requesting Startup Approval.

VENTILATION:
— Work plan describing ventilation equipment for each exposed worker.
Specify type of ventilation used below:
— Dilution Ventilation – Must produce velocity of 100 fpm at point of generation. (SOC IH will anemometer, upon request, for the Project Manager to measure velocity)
— Local Exhaust Ventilation - Must produce velocity of 100 fpm at point of generation and discharge contaminated air to location free of personnel. (SOC IH will provide tool, upon request, for the Project Manager to measure velocity)
— Push-Pull Ventilation System - Must produce velocity of 100 fpm at employee work area and move air away from the employee and discharge contaminated air to location free of personnel. (SOC IH will provide tool, upon request, for the NASA Project Manager, Resident Contractor Construction Manager, and Resident Contractor Supervisor to measure velocity)
RESPIRATORY PROTECTION:
— Supplied Air Respirators: Full-face tight-fitting facepiece, or air helmet/hood for each worker.
— Medical qualification documentation for each respirator user, for each type of respirator used on the project (including possible downgrade respirators, if applicable).
— Respiratory protection training documentation for each respirator user for the all equipment being used.
— Quantitative or qualitative fit test documentation for each user of a tight-fitting respirator for the specific respirator used.

— Check here if NASA Project Manager, Resident Contractor Construction Manager, and Resident Contractor Supervisor desires for the Contractor to be eligible for a possible respirator down-grade. If checked, the Contractor must provide the following:
    — Full-face or half-mask air purifying respirator (APR) or Powered Air Purifying Respirator (PAPR), both equipped with organic vapor cartridge with a P100 pre-filter

    Note: If above is not checked, Contractor may be required to wear supplied breathing air respirators for the duration of the project.

Specify type of breathing air compressor used:

— Oil- lubricated compressor - If this type is used, the Contractor must provide:
    — Carbon Monoxide Alarm (and alarm calibration documentation)
    — Air Sorbent and Filtration system
— Oil-Free (oil-less) compressor – If this type is used, the contractor must provide:
    — A calibrated carbon monoxide meter to verify carbon monoxide levels upon startup and each time the compressor location is changed (calibration documentation required).
— Training documentation that at least one Contractor employee is trained on the use of the breathing air system used.

Note: All respirators and associated components must be NIOSH approved.

PERSONAL PROTECTIVE EQUIPMENT:

— Tyvek (or similar) hooded coverall
— Nitrile Gloves
— Steel toed footwear
— Tyvek (or similar) Booties

NASA Project Manager, NASA Prime Contractor Construction Manager, or NASA Prime Contractor
Supervisor: _____

Date: _____